RAPHAEL SCHMUECKER MEMORIAL

SOLAR-HYDROGEN SYSTEM

OUR IMPROVED FARM TRACTOR AMMONIA AND HYDROGEN FUELING SYSTEM

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Topics

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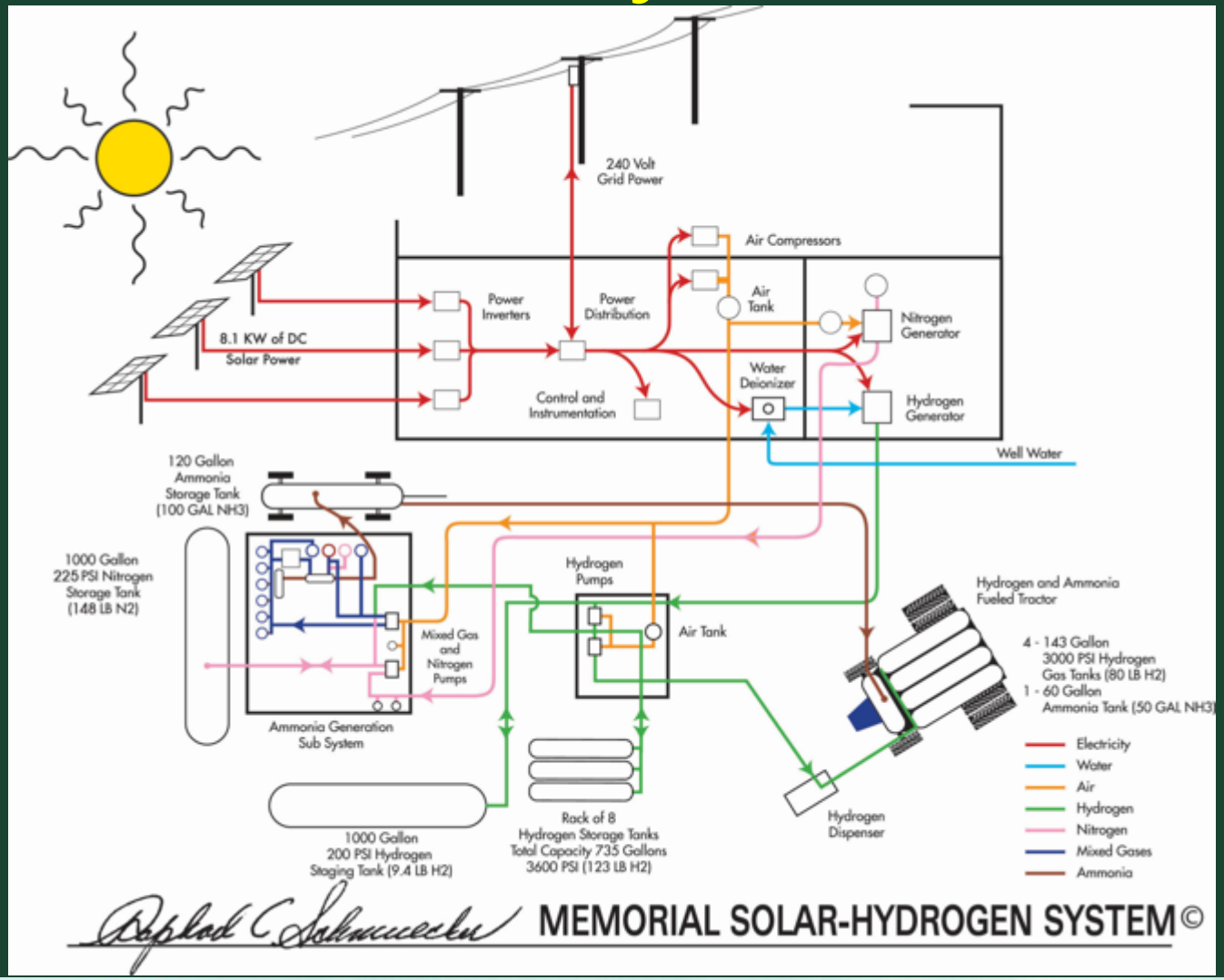
Why We Are Doing This

- The world's population is exploding.
- The planet's natural resources are being depleted.
  - With increased adverse environmental impact.
- Renewable, sustainable solutions are needed now.
  - Not just for our lifetime, but for 100's of years.

Why Are We Doing This

- Viability of electric cars is not apparent.
  - Infrastructure is needed to provide electrical storage for millions of vehicles.
  - Winter driving range is limited.
- Adoption of fuel cell powered vehicles is not widely accepted.
  - Materials to make 100 million vehicles a year.
  - Current fuel cell life is limited.
- “New Technology” takes ten’s of years to adopt.

Demonstration System Overview



Hydrogen Generation

- There is a yearly average 5 hours/day of full solar power.
- The Proton S40 hydrogen generator uses 7 Kwh to make .2 lb of hydrogen/hr or a pound of H2 a day.
- It takes 48 hours of operation to make hydrogen for a 10 gallon ammonia batch.

Nitrogen Generation

- A modified Dual Bed, Pressure Swing Absorption (PSA) unit generates super pure Nitrogen.
- The generator makes 13.5 lbs/hour.
- It takes 3.5 hours to make enough nitrogen to generate a 10 gallon ammonia batch.

Ammonia Generation

- The 3500 psi mixed hydrogen and nitrogen gases flow from the blue cylinders through the reactor, in the center, to make ammonia.
- The uncondensed gases flow to the red cylinder.
- It takes about 8 hours to make a batch of ammonia

C-FREE RENEW™

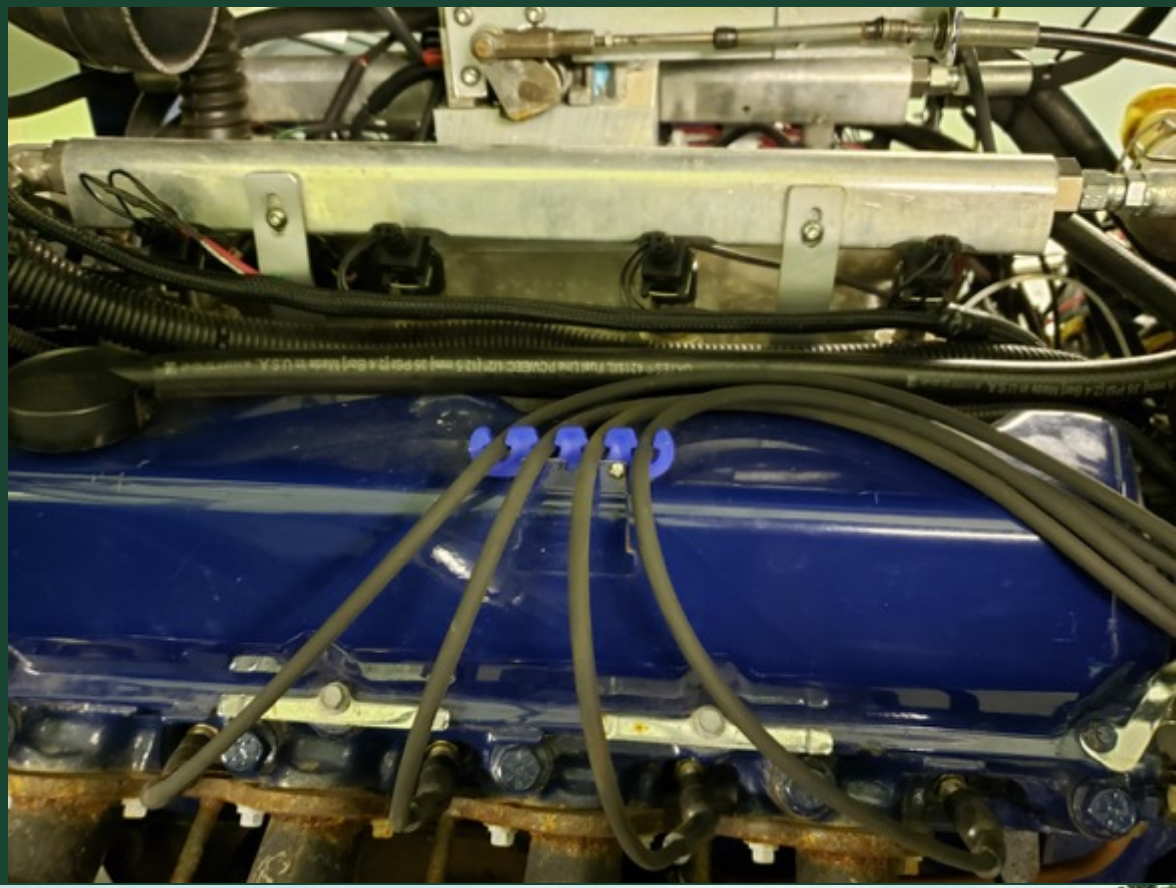
Tractor

Tractor

- 9.4 Liter V-8 Internal Combustion Engine.
- 13.5:1 Compression ration.
- Dual Fuel, H2 and H2/NH3.
- 150 Hp at 2,400 max rpm.
- Fuel generation & consumption produces no CO2.

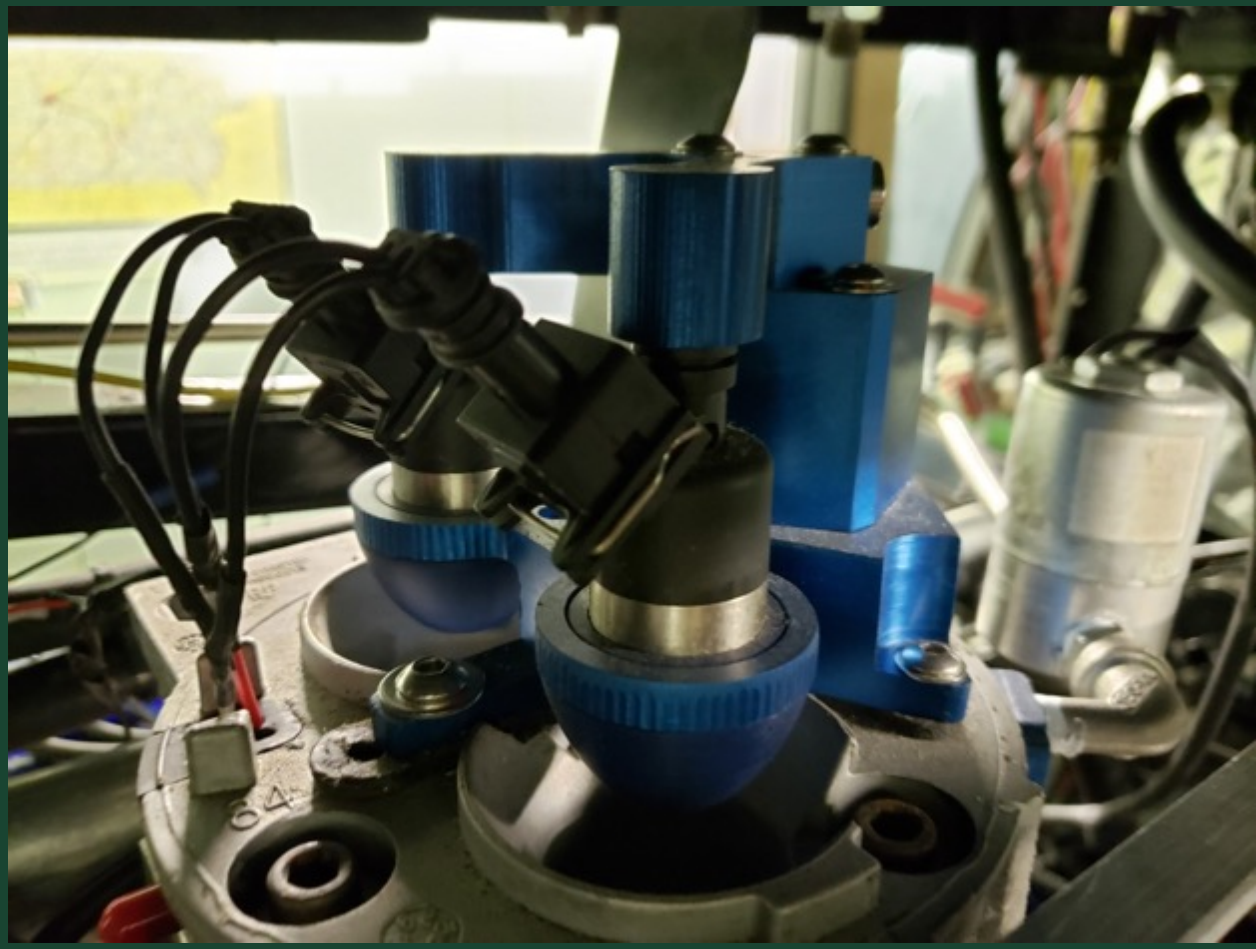
Tractor

- Pressure regulator reduces H2 pressure to a usable 75 psi.
- Port injection of H2 into cylinders.
- Spark ignited.



Tractor

- The throttle body injects liquid NH3 into the inlet manifold.



Tractor

- Programming computer in cab.
- Racing class Engine Control Unit (ECU).
  - Programmed maps for each fuel and RPMs
- Ignition by individual cylinder coils.
- No distributor.

Production Summary

- The ammonia generation system is 29% efficient.
  - 50.5 Kwh of power makes a gallon of ammonia (50,000 Btu or 14.6 Kwh.
- 64% of the energy goes to make the hydrogen.
- 23% goes to making nitrogen.
- 12% goes making ammonia and powering the controls.

Conclusions

- This self contained system demonstrates that with historical technology, carbon emission free fuel and fertilizer can be made from available raw materials and equipment; and renewable air, water and solar/wind renewable energy.
- Renewable energy can be stored as hydrogen or ammonia and then used as needed.
- Current hardware production can be increased by adding more solar panels, or wind turbines, to operate the subsystems longer and in parallel.

Conclusions

- Your Comments/Questions

- Find more about our system at:

www.solarhydrogensystem.com